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American Ferns—I: The ternate Species of Botrychium.

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The species now included in the genus *Botrychium* represent a clearly marked group of plants which are in many cases quite closely allied, a fact that has led to a considerable difference of opinion regarding the limits of the species. Two groups of the genus are made up of species that in their extreme forms approach each other, but still maintain certain characteristics of their own. So close is this approach that in the case of certain poorly preserved herbarium specimens it is difficult or sometimes almost impossible to distinguish the species, which in their living forms or even in well-preserved material are not to be confused. Of these two groups, one is composed of the species *B. Lunaria*, *B. boreale*, *B. lanceolatum* and *B. matricariaefolium*, which in America present a few peculiar modifications which are not, perhaps, of specific importance. The second group, known as the "*ternata*" group, is made up of the diminutive *B. simplex* in which two or more species have been confused, and the series of widely distributed but well-marked species that were confused with *B. ternatum* of Japan by Milde who has been followed more or less implicitly by English and American botanists. While it is evident that in some cases we must depend to a certain extent on habit and foliar cutting rather than on spore characters in order to separate the various species, in the great number of cases there are supplementary characters that will aid in their recognition. It is, of course, possible to assume a wide degree of variation in characters and

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thus reduce the species of the world to a minimum, but it seems the more logical course to recognize as species those groups of forms that are so clearly marked that no one would question them as distinct things, which though related sometimes rather closely, are not mistakable for one another and cannot be considered as variations induced by age, or by climate or environment acting on individuals recently alike. From any evolutionary standpoint we must necessarily consider all related species as originally springing from a common stock; but when characters have become so fixed as to be unmistakable, it is more simple, more convenient and more logical to recognize the groups of individuals bearing them as species.

The two species of *Botrychium* known to Linnaeus were included in his generic aggregate *Osmunda* which appears to us the more ridiculous because it contains plants which are now recognized as belonging to no less than four distinct families, the Ophioglossaceae, the Osmundaceae, the Polypodiaceae, and the Schizaeaceae. As compiled by Linnaeus in his *Species Plantarum* (1753), *Osmunda* contained the following species: *O. zelandica*, *O. Lunaria*, *O. virginiana*, *O. phyllitidis*, *O. hirta*, *O. hirsuta*, *O. adiantifolia*, *O. verticillata*, *O. cervina*, *O. bipinnata*, *O. filiculaefolia*, *O. regalis*, *O. Claytoniana*, *O. cinnamomea*, *O. Struthiopteris*, *O. Spicant* and *O. crispa*, species that are now scattered among the genera *Helminthostachys*, *Botrychium*, *Anemia*, *Acrostichum*, *Onoclea*, *Osmunda*, *Blechnum* and *Cryptogramma*. Other species were added to *Osmunda* by Thunberg, Cavanilles and Lamarck, so that the latter recognized 30 species in his Encyclopédie Methodique of which the volume containing this genus was published in the fourth year of the Republic (1797), and the number was not increased during the closing years of the century. In 1801 Swartz* cut off from this group three of the Linnaean species *O. Lunaria*, *O. virginiana* and *O. zeylandica*, which together with *O. ternata* Thunb. and a species of his own making, formed his genus *Botrychium*. He was none too soon for in the same issue of the same journal, Bernhardi, unaware of Swartz' work and evidently not informed by the editor of the duplication, established the genus *Struthiop-*

* Schrader's Journal für die Botanik 2[1]: 110. 1801.

teris for *O. regalis*, and its two allies, and left *O. Lunaria* and *O. virginiana* to stand for the genus *Osmunda*. It will thus be seen that it was a mere accident of priority of place in publication that prevented the species of *Botrychium* from bearing the name *Osmunda*, for mere deference to Swartz who was better known than Bernhardi, evidently led the editor to give precedence to Swartz' paper in the issue of his journal.

In 1806 Swartz,* after placing *O. cervina* in *Acrostichum*, *O. Struthiopteris* in *Onoclea*, *O. Spicant* (with another uncalled-for specific name) under *Blechnum*, and *O. crispa* under *Pteris*, cut off another genus from the Linnaean *Osmunda*, namely *Anemia*,† with seventeen species of which *O. phyllitidis* L. is first named, with *O. hirta*, *O. hirsuta*, *O. adiantifolia*, *O. bipinnata*, *O. verticillata* and *O. filiculaefolia* together with five species of Cavanilles, four of Lamarck and one by Swartz himself.

The varied practice of botanists with regard to fixing the group with which the Linnaean generic name shall hold is well illustrated by this comparatively simple case. It will show the absurdity of using some of the methods employed by modern botanists and serve to point out a line of nomenclatorial investigation that deserves consideration, since there has been neither uniformity in practice nor a definite ruling,‡ but which is more vital to stability than many of the problems that have reached essential uniformity in practice. The various methods hitherto employed for fixing the Linnaean generic name to a group of plants from which successive genera have been taken off are as follows:

1. The generic name must rise or fall with the first species described under the genus. In the case in hand this method would result in fixing the name *Osmunda* for the genus we now know as *Helminthostachys* § since *Osmunda zeylandica* was the first Linnaean species named. This plan is not commonly followed except in the case of genera that were monotypic with Linnaeus,

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*Synopsis Filicum. 1806.

† This name has been variously corrupted in orthography but this is the original form in which it was established.

‡ The Paris Code, Art. 54, leaves this point indefinite.

§ The name *Helminthostachys* was applied to this plant by Kaulfuss, 1824.

when no other course could be logically pursued. In practice, however, as shown below, this principle is not always followed even in the case of monotypic genera and we have in certain cases the anomaly of a Linnaean generic name applied to a group of plants not closely related to the one which was known to Linnaeus or his predecessors, and the Linnaean plant is now known under a totally different generic name.

2. The second method is to allow the original name to hold for that species or group of species which is left of the original Linnaean series after the successive genera have been taken out. This is known as "the method of residues," and is one commonly practiced. Since Swartz first carved *Botrychium* from the original *Osmunda* of Linnaeus, and Bernhardi followed it up by separating the members of the *O. regalis* group under the name *Struthiopteris*, this method applied to the case in hand would require the name *Osmunda* to stand for the group of species we now know under the name of *Anemia*.

3. Another method less frequently employed is to apply the name to the last of the residue left of the original genus as it existed when the first new genus was cut off. This course applied to the case in hand would also result in making the name *Osmunda* stand for the species of *Anemia*, since the additions made to the genus *Osmunda* by Lamarck and Cavanilles all happen to be species of either *Botrychium* or *Anemia*, and the former genus was the first to be separated from the Linnaean *Osmunda*. This plan is one that is sometimes followed far beyond the limits noted above, and the result occasionally happens that a Linnaean name is shifted from group to group of plants until it finally rests with a lot of species with no near relations to the original ones to which the name was first applied, or else as a means of reducing the difficulties in the case, some one suggests the dropping of the original name altogether, as has recently been proposed with the Linnaean *Jungermania* and has before been done with such genera as *Phallus* and *Lichen*.

4. A better course, but one which has been rarely used, especially in these later days, is to determine pre-Linnaean usage and to ascertain the source from which Linnaeus derived his name originally and then apply it to the species or group of species to

which it was first applied. It would seem that this is the only legitimate method to follow. In this particular case it would result in holding the name *Osmunda* for *O. regalis* and its allies to which it was applied by Tournefourt and others long before the compiler, Linnaeus, adopted it for the conglomerate group of plants which he called *Osmunda*. For the genera established after Linnaeus it would seem to be more rational to adopt as the type of the genus the first species mentioned under the genus as originally defined. This, however, raises the question as to what disposition shall be made of those early genera, which were not based on any species but were defined by a brief statement of characters; but it will surely have the effect to pin the regularly established genera down to some definite species so that whatever changes are made, the generic names will have a definite abiding place. We propose to apply this method to the genera of ferns in the discussions to be given in this series of papers on the American species.

For the present we will consider in historical sequence the various species of *Botrychium* of the "*ternata*" group that have been proposed by authors early and recent, and endeavor to supplement, for the American species particularly, the outline of specific limitations so clearly but briefly presented by the only modern investigator who has made an extended study of the group.* This study is based on an examination of the collections at Kew, Berlin and Paris, in addition to all the collections of importance, public and private, that are found in the United States, supplemented by a somewhat extended field examination of the genus as it occurs throughout the eastern half of the American continent. While our knowledge of the various species is by no means complete, the conclusions here reached are based on the widest possible array of attainable data.

1. BOTRYCHIUM TERNATUM (Thunb.) Swz.

The original member of the so-called "*ternata*" group of *Botrychium* was described and figured by Thunberg in his Flora Japonica in 1784. The description reads as follows:

* Prantl, Jahrb. des kön. bot. Gartens Berlin, 3: 1884. It is unfortunate that Prantl and other continental monographers could not have had access to a wider array of materials. The Germans have largely neglected to visit Kew and the English pteridologists have just as thoroughly neglected Paris and Berlin.

"Osmunda ternata. O. scapo caulino solitario, fronde tripartita supradecomposita. id. Tab. 32.

"Crescit circum Nagasaki, ubi semel legi.

"Floret Octobri, Nobembri.

"Radix fasciculata fibris numerosis, filiformibus, parum fibrillosis.

"Stipes inferne simplex, pollicaris, mox divisus in duas partes frondem scilicet et scapum floriferum.

"Frons solitaria, petiolata, supradecomposite ternata, glabra. Petiolus frondis compressiusculus, digitalis, inferne triternatus, nudus, superne frondosus, bipinnatus. Pinnae et pinnulae alternae, incisae, tenuissime serratae.

"Scapus e basi petioli frondis, teretiusculus, striatus, erectus, nudus, glaber, fronde duplo longior, apice cernuus, floriferus.

"Florum spica ramosa; Spiculae alternae antheris globosis.

"Conf. O. Virginica, Plum. Filic. p. 136, tab. 159."

The figure that accompanies this description very clearly represents a plant that is common in collections from Nagasaki and vicinity, but by no means includes all the species that have been discovered in Japan and distributed as *Botrychium ternatum*. By some oversight, or seeming lack of space, Thunberg's artist has drawn the figure with only two branches to the sterile segment, but from the description we must interpret this as an error, as pointed out by Kunze * many years ago.

Specimens of genuine *Botrychium ternatum* are to be seen in the Kew Herbarium from Japan, collected by Maximowicz, Oldham (two sheets), Pere Faurie and Maries; from China (Keio Kiang) Dr. Sherer; from India (northwest) collected by Falconer, (Khasya) Griffith, (Sikkim) C. B. Clarke. In Herb. D. C. Eaton is a Japanese specimen from Nagasaki, Oldham, which is curiously enough placed in the cover with Eaton's "Var. *australe*," another instance of a type being interpreted as a variety of itself! In Herb. Gray there are three sheets of true *B. ternatum* from Japan, one collected "Nov. 1889," one collected by Maximowicz, and one by Oldham, the last also mounted with a sterile leaf of the species mentioned below as *B. Japonicum* (Prantl). In the Herb. Mus. Paris, there is one specimen from India (Voy. Jacquiminot); four from Japan (Oldham; Savatier, n. 1611; and two "ex Franchet"); and two from China (M. Simon n. 16, and Perny). In the Berlin collection are some sixteen sheets from Japan, most of them typical, but a few somewhat smaller as are also some in

* Bot. Zeit. 6: 491. 1848.

our own collection from near Tokyo, communicated by Dr. Matsumura. In the Herb. California Academy of Science there is a single sheet of this species. These include all the genuine *B. ternatum* I have seen, and they represent a well defined species totally different from the many forms that have been referred to it by subsequent writers. No one, who holds any modern view of species, who has seen genuine specimens of *B. ternatum* from Japan, could hold for a minute that it was the same as the various species that occur in North America, and would adopt at once Prantl's masterly definition of this thin-leaved species with such a natural geographic range.

2. BOTRYCHIUM MATRICARIAE (Schrank) Spreng. Syst. Veg. **4**: 23. 1827.

Osmunda matricariae Schrank, Baier. Fl. **2**: 419. 1789.
Botrychium rutaceum Swz. Schrader's Journ. **2**: 111. 1801.
Botrychium matricarioides Willd. Sp. Pl. **5**: 62. 1810.
Botrychium rutaefolium A. Br.; Döll. Rhin. Fl. 24. 1843.

This appears to be the second member of the group described and it will be seen that it has been abundantly supplied with names, each one of which has been used in reputable monographs. We are indebted to Ascherson * for the elucidation of the synonymy. The species was described from Central Europe where it appears to have a somewhat widespread distribution. Numerous sheets of this species from Europe occur in the European herbaria and nearly all of the larger American collections possess a fairly representative series. There are a few specimens from the Northern United States and Canada which must be referred here; among these I would particularly mention a plant in our own herbarium collected by Mr. Pringle in "Old meadows, Vermont, September 26, 1878," which agrees perfectly with the figures represented by Luerssen, in fact more closely than any of the European specimens in our collection. A number of small specimens erroneously distributed under the name of "*Botrychium ternatum*, sub-var. *intermedium* D. C. Eaton," probably belong here also. The exact relation of this species to larger forms which are not clearly re-

* Syn. Mitteleurop. Fl. **1**: 109. 1896.
† Rabenhorst's Krypt. Fl. **3**: 584. *f. 182.*

ferable to any defined variety or species is not yet accurately made out. Most of these forms are confined to the Northern States and more particularly to New York and New England. These are various in size and this variation is doubtless due in part at least to age, but until we can cultivate the various forms and watch their development for a succession of years we shall probably have no very clearly marked data on which to base conclusions in regard to specific relationships. Botanical collectors to whom these northern forms are accessible can render an excellent service by watching the development of young plants through a succession of years, and that of different individuals under various environments.

3. BOTRYCHIUM BITERNATUM (Lam.) Underw. Bot. Gaz. **22**: 407. 1896.

The third fern of the "*ternata*" group to be described was the above species, which has also been singularly unfortunate in having too many names. After its original name of *Osmunda biternata* given it by Lamarck in 1797, it was next independently described in the genus *Botrypus* of Richard* as *Botrypus lunarioides*, which led Swartz a little later to transfer it to his earlier genus as *B. lunarioides*. Then Willdenow† described it anew as *B. fumarioides*, quoting both the prior names and citations, and Sprengel‡ seventeen years later, apparently dissatisfied with the work of his predecessors, after quoting all three of the preceding names, proceeds to baptize it anew as *B. fumariae* Sprengel! Surely the age of irruption in nomenclature is a thing of the past instead of the present. In thirty years this plant had three generic and four specific names and with the exception of Richard each successive author quoted all the names given by his predecessors!

The reasons for maintaining this species as distinct we have already given in the Botanical Gazette,§ and after having seen the type specimens at Paris and various supplementary specimens in numerous herbaria we are more than ever convinced that this

* Michx. Fl. Bor. Am. **2**: 274. 1803.

† Sp. Pl. **5**: 63. 1810.

‡ Syst. Veg. **4**: 23. 1827.

§ Bot. Gaz. **22**: 407. 1896; **23**: 464. 1897.

species is absolutely distinct from its congeners and can be recognized more clearly than any of the other species of this group by its unique biological characters as well as by its distinct form.

The specimen in the Michaux herbarium at Paris is badly folded, overlapping itself in such a way as to obscure some of its characters, yet it is clearly the same plant that we have seen growing in the South and that was figured in our Gazette article. The specimen bears no data as to time of collection except the brief record "in pascuis sabulosis juxta Charleston." In the general Paris Herbarium there are three other specimens, one of which bears no data except "Am. Sept."; the second "Caroline par Bosc an XI," and the third "des environs de Charlestown par Richard de l'herbier de Michaux 1808," all of which are the exact form which we have figured as stated above.

Additional specimens have been seen as follows:

Kew Herbarium: South Carolina, Charleston, Elliott (a torn and fragmentary specimen); Louisiana, New Orleans, Drummond, the latter differing only in slightly longer segments.

Berlin Herbarium: One specimen, typical, marked "*B. fumarioides* ex herb. Willd. 1806–12," without locality; and one Alabama specimen (Mohr, "Ex Herb. Mettenius"). In Willdenow's herbarium is a single specimen sent by Richard, so that the *B. fumarioides* Willdenow is exactly the *Botrypus lunarioides* Richard.

Gray Herbarium: Georgia, Burke county; Florida, Chapman; neither with dates of collection.

D. C. Eaton's Herbarium: South Carolina, L. R. Gibbs, 1846; Alabama, Mohr, April (plants dead ripe).

Davenport Herbarium: Alabama, Mohr, March, 1879 (4 plants); South Carolina? fragmental specimen marked "B. & M." ex herb. Phila. Acad.

Philadelphia Acad. Nat. Sci. Herbarium: One sheet with five plants, no locality given, marked "B. & M."

Walter Deane's Herbarium: South Carolina, Columbia, K. A. Taylor, May, 1890 (plants dead ripe); Alabama, Mohr (ex herb. Davenport).

Columbia University Herbarium: South Carolina, "St. John's F. P. Porcher, M.D.;" Charleston, "Comm. Dr. L. De Witte, 1838."

Canby Herbarium (N. Y. Coll. Pharmacy): A single specimen communicated by Lapham, marked "Lake Superior?" and penciled by D. C. Eaton as undoubtedly an error, which is surely the case.

These with the specimens collected by myself in Alabama and those previously quoted from the collection of Dr. Mohr, of Mobile, constitute all the available material that we can find in any public herbaria of this apparently widely distributed but rarely collected species. The habit of this plant growing on open grassy knolls where even botanists would scarcely look closely for plants in early spring, together with the fact that its short stem and sessile leaves causes it to be a very inconspicuous object, would account for its rarity in collections, had we not the added difficulty of the scarcity of competent field botanists in the Southern States. It is hoped that this second calling attention to the plant will result in a more extensive knowledge of its habits from future discoveries. It will be seen that there is not a particle of evidence to show that its period of maturing spores is due to anything in the climate, for *B. obliquum* its nearest ally is found in the very same regions, and like its northern congener matures late in the autumn. In the light of all the material that we have been able to examine, our friend Davenport's attempts to subdue the species* and to connect its unique period of maturity with straggling specimens from farther north appear more and more like a strained effort.

The petiole of the sterile segment while usually wanting is occasionally a centimeter long but it normally maintains its sessile character and the cutting of the segments is remarkably constant. When we include its biological characters and its unique period of spore maturity, we find it the most distinct of any of the species of this group, an opinion concurred in by all other botanists who have seen the plant in a living condition.

4. BOTRYCHIUM DISSECTUM Sprengel, Anleitung zur Kenntniss der Gewächse, **3**: 172. 1804.

This species is the fourth of the series that was recognized. Sprengel described it in these words:

*Bot. Gaz. **23**: 282–287. 1897; Fern Bull. **5**: 40–43. 1897.

"Eine neue Art habe ich aus Virginien erhalten, die ich *Botrychium dissectum* nenne. Der Wedel ist dreyfach getheilt und fast dreyfach gefiedert; die Blättchen der zweyten Ordnung sind lanzetförmig, stumpf und theilen sich in Keilförmige, stumpf gekerbte oder eingeschnittene Läppchen. Die Fruchtähre ist fast dreyfach gefiedert. Mit dem *Botrychium Virginicum* kommt diese Art einiger Massen überein, nur dass bey jenem die Blättchen der zweyten Ordnung spitzig zulaufen und in spitzig eingeschittene Läppchen getheilt sind. Michaux hat (Flor. boreali-americ. vol. II., p. 274), einen *Botrypus lunarioides* der mir dieser neuen Art in der dreyfachen Eintheilung des Wedels und der Aehre uberein kommt, aber er unterscheidet sich durch die rundliche Nierenform der Blättchen."

Considering the time in which this was written, the description is fairly good, and it indicates very clearly a species that is found very common in the vicinity of New York city, and thence southward, extending in the interior to Ohio, southern Indiana, and Kentucky. It is also found in various New England states, having been collected as far northeast as Essex county, Massachusetts, by Mr. John Robinson, but the typical form does not appear to be as common in New England as farther southward, particularly inland from the Atlantic coast. The species was well known to Willdenow, Pursh, Mühlenberg, Greville and Hooker, and by them properly recognized as a good species. It was fairly well figured by Schkuhr in 1809,* and less perfectly by D. C. Eaton in 1879,† the latter from a young or imperfectly developed specimen. Willdenow's herbarium contains a single rootless plant of this species sent by Mühlenberg, which is exactly typical of the species as known from New York southward.

This species reaches its fullest development in moist shady woods; a specimen in my collection from Whiteplains, New York, having a sterile lamina 22 cm. wide by 14 cm. high. The primary and secondary pinnae are cut down to a narrowly winged rachis scarcely more than a millimeter wide, and the pinnately arranged segments emerge alternately from this rachis by a lamina perhaps 2 millimeters wide, breaking up somewhat palmately into narrow tooth-like divisions which fork repeatedly and end normally in two divergent teeth. The stem is usually very short (2–2.5 cm.), the petiole of the sterile lamina is 7.5 cm. or less, the petiole of the sporophyll is 24 cm. or less long.

* Kryptog. Gewächse. *pl. 158.*

† Ferns of North America, 1: *pl. 20. f. 1.*

In mossy meadows in New England and Central New York, where exposed to the direct rays of the sun, the plant takes on a more contracted habit, the segments are much shortened and the plant approaches somewhat the form of segment seen in *B. obliquum* which often grows with it. But even under these circumstances the plants are unmistakable, and while they approach more nearly than at any other point, they do not blend one with the other, while in their normal development they are widely separated. In the New England plant growing in the above situations the petiole of the sterile lamina is much reduced and the lamina itself is usually much smaller than in fully developed forms of the species.

5. BOTRYCHIUM AUSTRALE R. Br. Prod. Fl. Nov. Holl. **1**: 164. 1810.

Of the two species described during the year 1810, this appears to be the first that was made known and was described as follows:

"B. australe, scapo subradicali, fronde ternata, foliolis bipinnatis, pinnulis confluentibus incisis. (J. D.) v. v. Port Jackson, Van Dieman's Land."

This brief description is utterly unsatisfactory, and, were it not for Robert Brown's plant at the Kew Herbarium together with several other plants from the type locality or from other portions of the Australian region, we might very easily unite this species with almost any of the others. With Brown's plant in existence it is hard to understand some of the later comments on the species. Greville and Hooker, in their Enumeratio Filicum,* say: "This comes very near to the preceding [*B. Virginicum*] in the size, habit, and other characters." J. D. Hooker in 1867 † refers this species to *B. cicutarium* Swz., a species as large as *B. Virginianum* which Plumier figured from San Domingo, but which so far as we know has not been rediscovered. D. C. Eaton likewise makes this the nominal basis of the var. *australe* of his composite species which includes the very large Californian plant which we shall refer to below under *B. silaifolium* Presl.

The plants of this species are comparatively small, the sterile

* Bot. Miscellany, **3**: 223. 1833.

† Handbook New Zeal. Fl. 387. 1867; *cf.* also Fl. Tasman. **2**: *pl. 169b.*

lamina of Brown's type being only 8 cm. wide by 6 cm. high; the others are somewhat larger, especially a specimen in the Kew Herbarium from New Zealand which measures 17 by 12 cm. The plants are fleshy and in texture approach some of the American species of the group more nearly than the Japanese *B. ternatum*; the segments, however, are very different and the characters are sufficient to keep the species distinct. There are nine sheets of this species in the Kew Herbarium with a distribution from Australia to Tasmania and New Zealand. A second New Zealand species will be noted below under *B. biforme* Colenso.

6. BOTRYCHIUM OBLIQUUM Mühl.; Willd. Sp. Pl. 5: 63. 1810.

This species, the most common in the eastern portion of America, was sent by Mühlenberg, under the above name, to Willdenow who published it as follows:

"B. scapo inferne unifrondoso, fronde subbiternato, foliolis oblongo-lanceolatis serrulatis basi inaequaliter cordatis. W.

"Botrychium obliquum. *Mühlenberg in litt.*

"Schiefe Mondraute. W.

"Habitat in Pennsylvania. (v. s.)

"Scapus quinquepollicaris basin versus unifrondosus. Frons irregulariter biternata. Foliola semipollicaria oblongo-lanceolata serrulata basi dilatata cordata valde inaequalia. Spicae bipinnatae. W."

Seventeen years later Sprengel, whose knowledge of the American species was based on very insufficient data, after redescribing *B. fumariae* (*B. biternatum*) added "*B. obliquum* Mühlenb. W. est junior planta" —a statement the more remarkable when we know the relative size of the two species! The type of this species is in Willdenow's herbarium at Berlin and consists of a small rootless specimen of the familiar eastern plant with the sterile lamina only 5.5 × 4 cm.; larger specimens from Mühlenberg also exist in the Kew Herbarium so that there is no doubt of the type of the species. It has the widest range of any of our species extending from Canada to Mexico, but is rare west of the Mississippi River. A thin leaved southern form which ranges from Florida to Texas may be worthy of varietal rank at least. The exact relations of Eaton's "sub-var. *intermedium*" to this species are also difficult to discover and will possibly involve cultivation to elucidate relationship; much doubtless depends on age and environment.

7. BOTRYCHIUM SILAIFOLIUM Presl, Rel. Haenk. 1: 76. 1830.

B. ternatum, var. *australe*, D. C. Eaton, Ferns N. Am. 1: *pl. 20a.* 1879 (in part). Not *B. australe* R. Br.

Presl described this species as follows:

"B. fronde radicali tripinnata, pinnis primariis secundariisque petiolatis, pinnulis subsessilibus ovatis crenato-dentatis, inferioribus sublobatis, scapo nudo, panicula coarctata. Hab. Nootka-Sund.

"Frons radicalis solitaria ambitu cordato-ovata, tripinnata, petiolo tripollicari rhachibusque sulcato. Pinnae primariae 5-pollicares oppositae petiolatae patentes ovatae obtusae. Pinnae secundariae sesquibipollicares suboppositae petiolatae oblongo-lanceolatae. Pinnulae alternae et suboppositae ovatae obtusae glaberrimae carnulosae virides, inferiores, 5–6 lineas longae subsessiles trilobae, mediae sessiles ovato-lanceolatae bilobae et profunde dentatae, supremae crenato-dentatae. Scapus pedalis sulcatus, fronde aequilongus. Panicula secunda ramosa, ramis suboppositis ramosissimis, inferioribus ultra 3 pollices longis.

"Capsulae luteae magnitudinae seminis Milii. Semina flavo-viridia."

Greville & Hooker in their Enumeratio Filicum * speak of this as "a very distinct species as appears from the description," and this early opinion appears to be the correct one.

Through the kindness of Dr. Victor Schiffner of Prag, we have been able to see the original type from Presl's herbarium and it coincides exactly with the forms that are more or less common in collections from California. Dr. M. A. Howe has collected very fine specimens at Sisson, near Mt. Shasta, in well shaded woods at an altitude of about 3,500 feet. Other plants are in collections from farther south in the Sierras, and there is a specimen at Berlin, collected in the Cascade Mountains, Oregon, by Howell. Dr. Howe's specimens were collected 31 July and are very immature, the old leaf of the preceding season persisting, the young lamina unfolding and the sporangia well-formed but still partly unfolded as is also the case with Presl's plant which is only a little farther advanced. The species has been fairly well figured in outline in Eaton's Ferns of North America as var. *australe* (California form only) but how it could have been possible to confuse this noble species with the much smaller *B. australe* R. Br. from Australia is hard to understand!

* Bot. Misc. 3: 224. 1833.

8. BOTRYCHIUM DAUCIFOLIUM Hook. & Grev. Icon. Fil. **2**: *pl. 161.* 1831.

B. subcarnosum Wall. Cat. no. 49. *nomen nudum;* Hook. & Grev. Bot. Misc. **3**: 222. 1833.

This plant appears to be the next species which was definitely made known. In the Kew Collection, in addition to the earlier plants of Wallich, there are abundant recent specimens. The plant is a coarse species with the sterile lamina ranging up to 30 cm. broad and 25 cm. long; the petiole of the sterile lamina is usually short (4–6 cm.); the stem is elongate, often up to 3 dm. The plant is ternate but the two lower divisions are alternate, varying as much as 1–2 cm. in their origin; the texture is thin, the veins being clearly visible and consist in each segment of a main vein pinnately branched and a second smaller supplementary vein rising below the midvein. This feature is very characteristic, appears in very small segments, and is very different from the figures given by Greville (*loc. cit.*) which shows an ordinary pinnate midvein. The segments are set at an angle of about 45° to the rachis and the lower are often lobed on one or both sides. Very large specimens rarely show a second smaller supplementary vein.

The species is represented by fifteen sheets in the Kew Herbarium, besides a specimen from Samoa gummed on a sheet with *B. Japonicum* mentioned below. The distribution includes Nepal, Nilgherries, Sikkim, Ceylon, Birmah, Society Islands, Samoa. A single specimen from Java has more acuminate segments, lacks the supplementary vein and deserves further study.

B. subcarnosum differs mainly in its smaller size, shorter petiole to the sterile lamina, and more simple panicle; it can hardly be maintained as distinct.

9. BOTRYCHIUM DECOMPOSITUM Martens & Galeotti, Mem. Acad. Sci. Bruxelles **15**:—(15). *pl. 1.* 1842.

Although D. C. Eaton referred this also to his all-embracing *B. ternatum* var. *australe*, we shall be obliged to hold it distinct from *B. silaifolium* to which it is allied, for the present at least, until we can know more definitely the limits of the two species, their habits and field characters. Liebmann's plant in Herb. Kew and

Bourgeau's Orizaba plant, no. 3194, in the same collection, are fairly typical forms as figured in the original publication. A sterile plant in the Columbia Herbarium, collected in Orizaba by Müller, is also fairly typical of the species as originally described and figured. Not all the Mexican forms of this group can be referred to the same species. Besides *B. obliquum* there are, at present, indications of at least three distinct species from Mexico, and while these are already represented by specimens in our own collection, detailed information regarding their characters, habits, and distribution is very much desired.

10. BOTRYCHIUM SUBBIFOLIATUM Brack. U. S. Expl. Exped. 317. *pl. 44. f. 2.* 1854.

This very distinct species from the Sandwich Islands which Brackenridge beautifully figured, in spite of its reference to *B. ternatum* by Eaton and to *B. daucifolium* by Baker, must stand as a clearly defined species, its alliance being with *B. daucifolium*. The type is at Washington in the National Herbarium and duplicates of it are at Kew together with two other specimens both imperfect; in the Berlin Herbarium are three fine specimens, two from the Herb. Hillebrand collected by Baldwin and Lydgate, and one collected by Remy; these with a single imperfect specimen in the Paris Herbarium appear to be the only material accessible. The sterile lamina is about 15 by 11 cm., the stem about 7 cm. and the petiole of the sterile lamina about 11 cm. As it appears to have been rarely collected and little is known of its habit, additional material is very much desired, the more so since the Hawaiian Islands have become a part of our own country.

11. BOTRYCHIUM BIFORME Colenso, Trans. New Zeal. Inst. **18**: 223. 1886.

This is surely a distinct species as shown from various specimens in the Kew Herbarium including one collected by G. Bennett 1863,* and a sheet of several specimens from Colenso himself.

* With the Bennett specimen there is a letter from Mr. Bennett to J. D. Hooker which is endorsed, "In every particular this is *Botrychium dissectum* of North America." The specimen is glued to the same sheet with a specimen marked "*Botrypus dissectus* P., Herb. Pursh propr." and this serves to emphasize the contrast between the two species which even a novice would recognize as distinct.

There is a single specimen in the Columbia Herbarium which is also to be referred here. It is possible that there is an earlier name for the species, but we have not been able to find any. Notwithstanding Mr. Baker's assertion to the contrary † it does not "exactly match the North American *B. dissectum* Muhl." or come anywhere near doing so, and one must have defective vision to think of confusing the two species even though they are both forms with narrow segments.

To the above list of species, all of which, with the single exception of *B. daucifolium*, have been confused with *B. ternatum* at one time or another, we are obliged to add three more:

12. BOTRYCHIUM COULTERI sp. nov.

A stout fleshy plant growing in geyser formations. Roots numerous, fleshy, stout; stem very short, 2–3 cm. long, very stout, 1.5–2 cm. in diameter, swollen with the contained bud of the succeeding season, soon dividing to form the sterile and fertile laminae; petiole of the sterile lamina very short, 2–2.5 cm. long, stout, sulcate in drying; sterile lamina about 15 cm. wide, the central portion about 9 cm. long, this and the lateral ones tripinnate, or quadripinnatifid; segments obliquely ovate, 1 cm. or more long, 0.5 cm. or more wide, thick, fleshy, the margin entire or slightly repand; veins few, scarcely perceptible; petiole of the sporophyll about 17 cm. long including the panicle; panicle quadripinnate below, the pinnae crowded, gradually simpler above; sporangia very numerous, bright yellow; spores copious, pale yellow.

The leaf persists well into the second season, the new stem growing through the base of the old, the marginal portion of which surrounds it like a sheath; the plant is slightly hairy throughout when young; the bud is very large, and somewhat hairy at the margins of the pinnae but not densely pilose like that of *B. obliquum*. The sporophyll is not uncommonly double.

In geyser formations near a stream in open places, Yellowstone National Park, P. A. Rydberg and Ernst A. Bessey, 7 Aug. 1897. Dr. Rydberg and his assistant collected some 150 specimens of this interesting species. It was apparently first collected by Dr. John M. Coulter, at Lower Fire Hole Basin, 1872,

† Annals of Botany, 5: 500. 1891; New Ferns, 117.

as shown by specimens in the collections of T. C. Porter; we take pleasure in naming it for its original collector. Specimens are in the U. S. National Herbarium collected by J. M. Coulter at Teton Lake (Hayden's Expedition), Yellowstone Park, Tweedy, 1885, and small young specimens in grassy meadows near Moscow, Idaho, L. F. Henderson. Specimens are in the Gray herbarium from Shoshone Basin, August 23–26, 7,800 ft. marked, "Grows in all the Geyser Basins, C. R."

Dr. Rydberg who has seen this species in life in abundance says that it differs in habit from the eastern *B. obliquum* as widely as that species differs from *B. Virginianum;* it is very distinct from any of our other species.

14. BOTRYCHIUM OCCIDENTALE sp. nov.

A tall fleshy plant of open woods. Roots fibrous, fleshy; stem short, 2–5 cm. long, 5 mm. or more in diameter; petiole of the sterile lamina 11–12 cm. long, rather slender; lamina very large, 18–20 cm. broad, 13–14 cm. high, the lateral divisions bipinnate with about 5 pairs of mostly opposite pinnae; the terminal division tripinnatifid, gradually simpler above; ultimate segments nearly oval, mostly narrow (under 5 mm. wide), the margins finely but irregularly crenulate; texture fleshy, the veins indistinct; sporophylls 4 dm. long (including the panicle which ranges from 10–15 cm.), tripinnate almost throughout its entire length; bud densely hairy with white silky hairs.

New Westminster, British Columbia, 31 July 1897 and 7 Oct. 1897. A fine series collected by Mr. A. J. Hill are in our herbarium. Specimens collected at Sproat, Columbia River, July 18, 1890 (Macoun), and from the Yakima region, Washington (Brandegee), are in the herbarium of the California Academy of Science, and at both Kew and Berlin are excellent specimens collected by Dr. Lyall, 1858–9, on the Oregon Boundary Commission, latitude 49° N.

15. BOTRYCHIUM JAPONICUM (Prantl).

Botrychium daucifolium β Japonicum Prantl, Jahrb. des kön. bot. Gartens Berlin, **3**: 340. 1884.

A tall forest plant with thin foliage. Stem slender, 7–9 cm. long (in younger plants as short as 3 cm.), often clothed with the

scarious base of the stem of the preceding year; petiole of the sterile lamina 9–12 cm. (in younger plants not exceeding 3.5 cm.); sterile lamina 23 cm. or less wide, the central portion 14 cm. or less high, this and the lateral portions twice pinnate; pinnae broadly lanceolate, 3–6 cm. long, thin, the lowest again pinnate, the upper merely pinnatifid, with narrow sinuses; margin everywhere sharply serrulate with teeth 0.5 mm. long, curving upwards; sporophylls 30–35 cm. long including the panicle, slender; panicle tripinnate with rather wide rachises so that the sporangia appear to be turned to one side.

Japan, "In silvis prope urbem Tokyo, frequens," J. Matsumura; Shimogamo, Kyoto, October 1893, "not common," Tasuke Hattori. Plants marked in Professor Prantl's own writing appear in the Berlin herbarium.

This is the Japanese plant that Baker refers to *B. daucifolium* and is the one mentioned as *B. daucifolium* in Franchet and Savatier's Enumeratio* as shown by Franchet's own plants in the Paris herbarium. It is more or less common in collections from Japan and has been indiscriminately taken for *B. ternatum* and *B. daucifolium*. While it has nothing closely in common with the former, it differs from the latter in its more delicate texture, and widely in the cutting of its sterile lamina. It is a very clearly marked species. Its common name in Japan is said to be "hanawarabi."

The ternate species of *Botrychium* as thus outlined have a distribution covering all the continents except Africa; the described species are distributed as follows:

Europe (1): *B. matricariae.*

Asia (3): Japan—*B. ternatum, B. Japonicum;* China—*B. ternatum;* India—*B. daucifolium, B. ternatum.*

Australasia (4): Hawaii—*B. subbifoliatum;* New Zealand—*B. australe, B. biforme;* Australia—*B. australe;* Tasmania—*B. australe;* Samoa—*B. daucifolium;* Java—*B. daucifolium* var. (?)

North America (8): *B. obliquum* (Eastern and Southern), *B. obliquum intermedium* (Northeastern), *B. dissectum* (Eastern), *B. matricariae* (Northeastern), *B. biternatum* (Southern), *B. Coulteri* (Rocky Mountains), *B. silaifolium* (Pacific Coast), *B. occidentale* (British Columbia), *B. decompositum* (Mexico).

* Enum. pl. in Japonia sponte crescentium, 2: 252. 1879.

South America: Two species undescribed from Colombia and Argentina.

Besides the above, there are two forms from Mexico, one from Alaska, one from Guatemala and one from Jamaica, too little known at present for accurate description and limitation.

Possibly a brief account of the materials which have been examined may be of interest as it will apply as well to other genera of ferns, which have been studied already. The Kew herbarium has by far the richest series in the world, based on Hooker's original collection and supplemented by extensive collections in British colonies and many others variously obtained, among them the finest series of duplicates from Fée's rich gatherings that we have seen. In this group of *Botrychium* there are at Kew 138 specimens.

The Berlin collection stands next in value in Europe, representing in addition to types of Willdenow, Sturm, and Kunze, the extensive collection of Mettenius, and Hildebrand's Hawaiian Island herbarium. It also contains the results of the work of Kuhn and Prantl, the untimely death of each of whom has deprived Germany of a master in pteridology. In this group we found 108 specimens at Berlin, there being an unusually large series of *B. matricariae*.

The Paris collection is small and poor, though much valuable material (including Fournier's types) is unmounted and stored in the attics of the old fire trap in which it is housed. It is a noteworthy fact that the best collections from the French colonies and the specimens of the French pteridologist, Fée, are best represented not at Paris, but at Kew and Berlin; we found only 34 specimens of this group at Paris.

The American public collections are better known on this side of the water and contain naturally a vastly better representation of the plants of the United States (though not of Mexico and the West Indies), than do those of Europe. The Gray Herbarium furnished opportunity to study 64 specimens of this group, the National Herbarium 40, the Herb. Philadelphia Academy of Sciences 16, and the Columbia Herbarium 50, at least two thirds of which are specimens from the United States. The Canby Herbarium in the College of Pharmacy, New York, the herbarium of Lafayette College, kindly loaned by Dr. Porter before the fire, the herbarium

of the California Academy of Sciences and that of Cornell University furnished each additional material of interest.

Of private collections, that of Walter Deane, though of limited range, contains the finest specimens from the Eastern States, some of them of matchless perfection, in all 39 specimens; that of Professor D. C. Eaton is very rich in forms, with 77 specimens; that of Mr. Davenport with 44 specimens from this group, many of which are scrappy, contains a number of interesting forms; these together with 112 specimens in our own herbarium, to say nothing of literally thousands of specimens examined in the field have furnished the data for this paper. Very much is yet to be known, particularly of the species of Mexico, West Indies, and South America.

COLUMBIA UNIVERSITY,
1 August 1898.

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A Correction.

In the March number of the BULLETIN an unfortunate error occurred resulting in the necessity of renaming a species there described. We suggest the following emendation:

SELAGINELLA ARENICOLA Underw.

Selaginella arenaria Underw. Bull. Torr. Bot. Club, **25**: 129, 1898, not *S. arenaria* Baker.

L. M. UNDERWOOD.

8 OCTOBER 1898.